— (A)mplitude (M)odulation —

→ AM wave

Modulating signal
Base bond signal
$m(t)$ → [Modulation] →   Modulated Signal
             ↑   (High frequency)

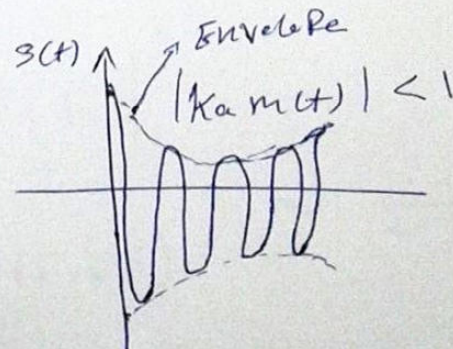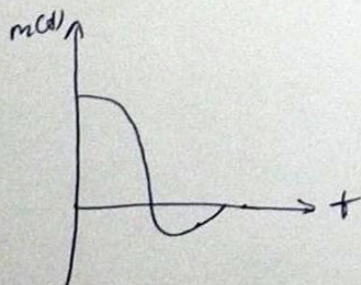   Carrier $S(t)$

         $C(t)$

         Cos & sine

$$C(t) = A_c \cos(2\pi f_c t + \varphi) \implies \text{Carrier wave}$$

$$C(t) = A_c \cos(2\pi f_c t) \quad \text{in AM wave}$$

* Types of modulation

[I] $\boxed{S(t) = A_c [1 + K_a m(t)] \cos(2\pi f_c t)} \Rightarrow$ AM wave

$$= A_c \cos(2\pi f_c t) + K_a A_c \cdot m(t) \cos(2\pi f_c t)$$

            ↓

         $C(t)$ $+ K_a m(t) * C(t)$

$K_a \longrightarrow$ amplitude senstivity of AM wave

$m(t)$

$S(t)$ Envelope

$|K_a m(t)| < 1$

AM wave in time domain
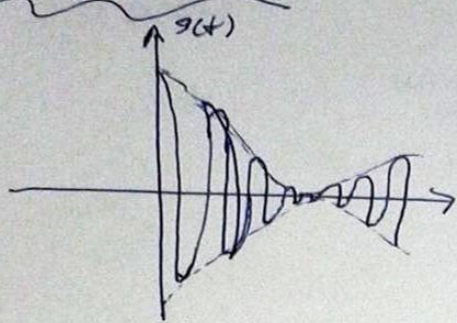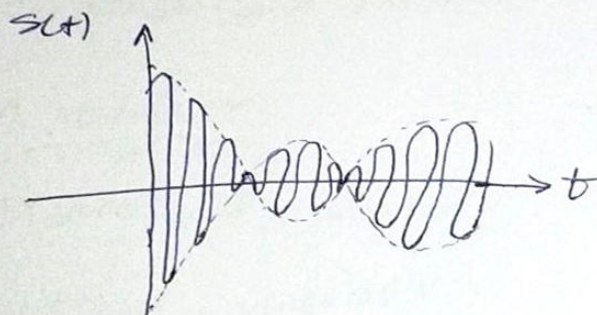
-1-

* if $|k_a m(t)| = 1$

$\underbrace{\qquad\qquad}$

$s(t)$

* overlap

$\vee \underline{\qquad\qquad} \vee \underline{\qquad\qquad} \vee \underline{\qquad\qquad} \vee$

* if $|k_a m(t)| > 1$

$s(t)$

$\longrightarrow t$ * over modulation

$|k_a m(t)| < 1$ ← أنظمة الحالة هي الحالة الرئيسية →

كي ترجع $m(t)$ في الرئيسي (نقل) (recover) .

Percentage Modulation = $|k_a m(t)| * 100$

*

$$s(f) = A_c \left[\cos(2\pi f_c t) + k_a A_c * m(t) \cos(2\pi f_c t) \right]$$

$$= \frac{A_c}{2} \left[\delta(f - f_c) + \delta(f + f_c) \right]$$

$$+ \frac{k_a A_c}{2} \left[M(f - f_c) + M(f + f_c) \right] \qquad m(t) \rightleftharpoons M(f)$$

-2-

* **Amplitude Spectrum for AM wave.**
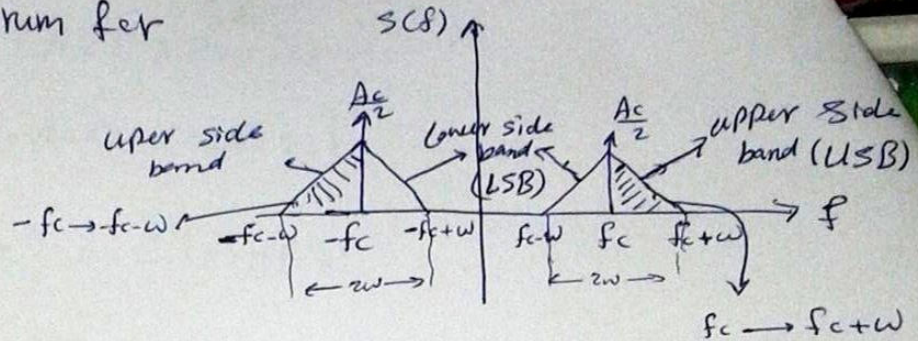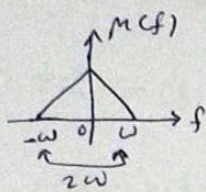
* **Transmition Bandwidth for AM wave = 2W**

$W \Rightarrow$ Baseband frequency

* **AM modulator:-**

① Square - law Modulater

② Switching - Modulater

1- square -law

Square law Modulater   band Pass filter
                        tund of f_c
                        $\leftarrow 2W \rightarrow$
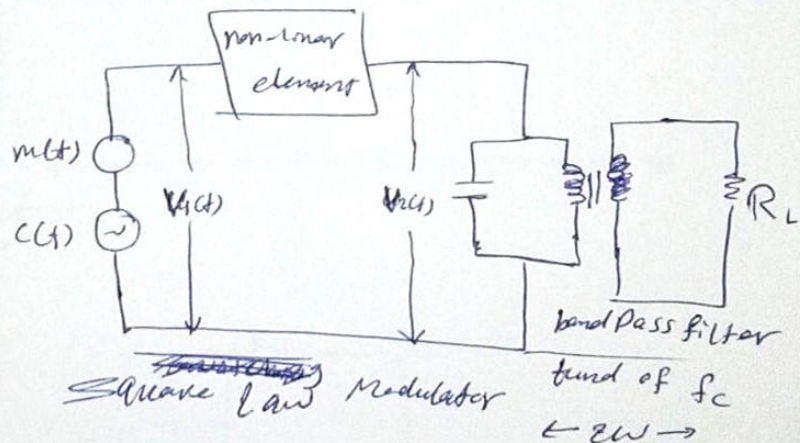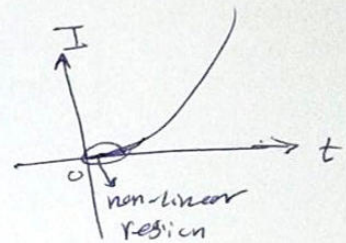
$V_1(t) = m(t) + c(t)$

$\quad = m(t) + A_c \cos(2\pi f_c t)$

$V_2(t) = a_1 V_1(t) + a_2 V_1^2(t)$

$$V_2(t) = a_1 [m(t) + A_c \cos(2\pi f_c t)]$$

$$+ a_2 [m(t) + A_c \cos(2\pi f_c t)]^2$$

$$= a_1 m(t) + a_1 A_c \cos(2\pi f_c t)$$

$$+ a_2 m^2(t) + 2a_2 A_c m(t) \cos(2\pi f_c t) + a_2 A_c^2 \cos(2\pi f_c t)]$$

$$S(t) = A_c [1 + k_a m(t)] \cos(2\pi f_c t)$$

$$V_2(t) = A_c [a_1 + a_2 m(t)] \cos(2\pi f_c t)$$

$$+ a_1 m(t) + a_2 m^2(t) + a_2 A_c^2 \cos^2(2\pi f_c t)]$$

✦ OUTPUT of BPF :-

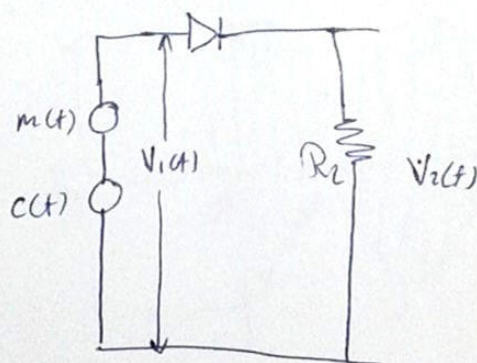$$= A_c a_1 \left[1 + \left(\frac{2a_2}{a_1} \right) + m(t) \right] \cos(2\pi f_c t)$$

AM wave k_a

✦ —————— ✳ —————— ✳ ———— ✳

② Switching modulator :-

Diode ⟶ Ideal case

Switching Modulator

$$V_1(t) = A_c \cos(2\pi f_c t) + m(t)$$

* $c(t) \geq 0$ Diode on

* $e(t) < 0$ Diode off

$$V_2(t) = \begin{cases} V_1(t) & c(t) > 0 \\ 0 & c(t) < 0 \end{cases}$$

$g_p(t)$

Pulse - train

$$T_0 = \frac{1}{f_c}$$

$$V_2(t) = V_1(t) - g_p(t)$$
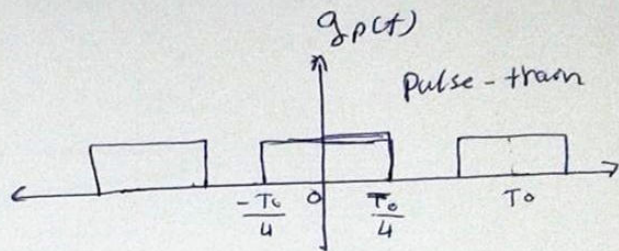
$$g_p(t) = \frac{1}{2} + \frac{1}{\pi}\left[\sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2^{n-1}} \cos\left[2\pi f_c t (n-1)\right]\right]$$
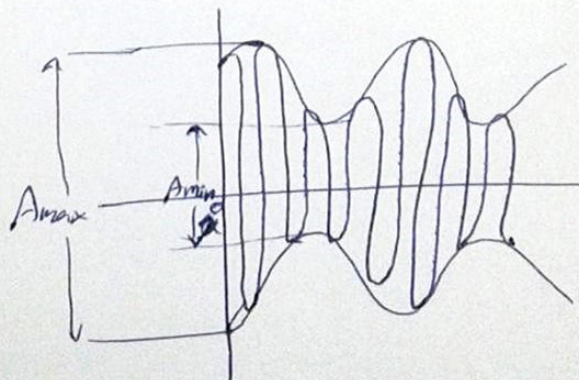
$n = 2$

$n > 2 \implies$ Project by BPF

$$V_2(t) = \frac{A_c}{2}\left[1 + \frac{4}{\pi A_c} m(t)\right] \cos(2\pi f_c t)$$

Modulation Index ...

$$\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$$

$$P_c = \frac{A_c^2}{2}$$

$$P_{LSB} = \frac{1}{8} \mu^2 A_c^2$$

$$P_{uSB} = \frac{1}{8} \mu^2 A_c$$